Danqing Wang

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EDUCATION

University of California, Berkeley, Berkeley, CA — Sept. 2019 –
Postdoctoral Research Fellow
Faculty host: Junqiao Wu
Department of Materials Science and Engineering

Northwestern University, Evanston, IL — June 2019
Ph.D. in Applied Physics
Co-advisors: Teri W. Odom, George C. Schatz
Thesis: *Manipulating Light-Matter Interactions with Plasmonic Nanoparticle Lattices*

Nanjing University, Nanjing, China — June 2013
B.S. in Physics

FELLOWSHIPS & AWARDS

2022 Rising Stars in EECS Workshop, Class of 2022

2020 Forbes 30 Under 30 in Science, Class of 2021

2019 Miller Research Fellowship, University of California, Berkeley

2018 Material Research Society Graduate Student Award (GSA) Silver Award

2018 Excellent Poster Award, Gordon Research Conference on Lasers in Micro, Nano and Bio Systems

2018 Honorable Mention, International Precious Metals Institute (IPMI) Student Award

2018 Chinese Government Award for Outstanding Self-Financed Students Abroad

2017 Outstanding Research Award, International Institute for Nanotechnology (Northwestern University)

2013 Excellence Award in National Undergraduate Innovation Training Program, China

PUBLICATIONS

[h-index: 21, i10-index: 23, total citations > 1700. Google Scholar link.]

First and co-first author

0. Yang, A.; **Wang, D.*** "Emerging Optics with Structured Nanomaterials," ***Progress in Quantum Electronics***, *in preparation*, *invited review* (*corresponding author)

1. **Wang, D.***; Dong, K.; Li, J.; Grigoropoulos, C.; Yao, J.; Hong, J.; Wu, J.* "Low-loss, geometry-invariant optical waveguides with near-zero-index materials," ***Nanophotonics*** 11, 21, 4747–4753 (2022) DOI: 10.1515/nanoph-2022-0445 (*corresponding author)

2. **Wang, D.**; Bourgeois, M.R.; Guan, J.; Fumani, A.K.; Schatz, G.C.; Odom, T.W. "Lasing from Finite Plasmonic Nanoparticle Lattices," ***ACS Photonics*** 7, 630-636 (2020) DOI: 10.1021/acsphotonics.0c00231

3. Fernandez-Bravo, A.[+]; **Wang, D.**[+]; Barnard, E.S.; Teitelboim, A.; Tajon, C.; Guan, J.; Schatz, G.C.; Cohen, B.E.; Chan, E.; Schuck, P.J.; Odom, T.W. "Ultralow-threshold, continuous-wave upconverting lasing from subwavelength plasmons," ***Nature Materials*** 18, 1172–1176 (2019) [Highlighted by News and Views, *Nature Materials*] DOI: 10.1038/s41563-019-0482-5 ([+]equal contribution)

4. **Wang, D.**; Guan, J.; Hu, J.; Bourgeois, M.R.; Odom, T.W. "Manipulating Light-matter Interactions in Plasmonic Nanoparticle Lattices," ***Accounts of Chemical Research*** 52, 2997-3007 (2019) DOI: 10.1021/acs.accounts.9b00345

5. **Wang, D.**; Bourgeois, M.R.; Lee, W.; Li, R.; Trivedi, D.; Knudson, M.P.; Wang, W.; Schatz, G.C.; Odom, T.W. "Stretchable Nanolasing from Hybrid Quadrupole Plasmons," ***Nano Letters*** 18, 4549–4555 (2018) DOI: 10.1021/acs.nanolett.8b01774

6. **Wang, D.**; Yang, A.; Wang. W.; Hua, Y.; Schaller, R.D.; Schatz, G.C.; Odom, T.W. "Band-edge Engineering for Controlled Multi-modal Nanolasing in Plasmonic Superlattices," ***Nature Nanotechnology*** 12, 889 (2017) [Highlighted by News and Views, *Nature Nanotechnology*] DOI: 10.1038/nnano.2017.126

7. **Wang, D.**; Wang. W.; Knudson, M.P.; Schatz, G.C.; Odom, T.W. "Structural Engineering in Plasmon Nanolasers," ***Chemical Reviews*** 118, 2865–2881 (2017) DOI: 10.1021/acs.chemrev.7b00424

8. Tran, T.T.[+]; **Wang, D.**[+]; Xu, Z-Q.[+]; Yang, A.; Toth, M.; Odom, T.W.; Aharonovich, I. "Deterministic Coupling of Quantum Emitters in 2D Materials to Plasmonic Nanocavity Arrays," ***Nano Letters*** 17, 2634-2639 (2017) DOI: 10.1021/acs.nanolett.7b00444 ([+]equal contribution)

9. **Wang, D.**; Yang, A.; Hryn, A.J.; Schatz, G.C.; Odom, T.W. "Superlattice Plasmons in Hierarchical Au Nanoparticle Arrays," ***ACS Photonics*** 2, 1789 (2015) DOI: 10.1021/acsphotonics.5b00546

<u>Co-author</u>

10. Dong, K.; Zhang, T.; Li, J.; Wang, Q.; Yang, F.; Rho, Y.; **Wang, D.**; Grigoropoulos, C.P.; Wu, J.; Yao J. "Flat bands in magic-angle bilayer photonic crystals at small twists," ***Phys. Rev. Lett.*** 126, 223601 (2021) DOI:10.1103/PhysRevLett.126.223601

11. Guan, J.; Sagar, L.K.; Li, R.; **Wang, D.**; Bappi, G; Wang, W.; Watkins, N.; Bourgeois, M.R.; Levina, L.; Fan, F.; Hoogland, S.; Voznyy, O.; Martins, J.; Schaller, R.D.; Schatz, G.C.; Sargent,

E.H.; Odom, T.W. "Quantum dot-plasmon lasing with controlled polarization patterns," ***ACS Nano*** 14, 3426–3433 (2020) DOI: 10.1021/acsnano.9b09466

12. Guan, J.; Sagar, L.K.; Li, R.; **Wang, D.**; Bappi, G; Watkins, N.; Bourgeois, M.R.; Levina, L.; Fan, F.; Hoogland, S.; Voznyy, O.; Martins, J.; Schaller, R.D.; Schatz, G.C.; Sargent, E.H.; Odom, T.W. "Engineering Directionality in Quantum Dot Shell Lasing Using Plasmonic Lattices," ***Nano Letters*** 20, 1468-1474 (2020) DOI: 10.1021/acs.nanolett.9b05342

13. Lin, Y.; **Wang, D.**; Hu, J.; Liu, J.; Wang, W.; Schaller, R.D.; Odom, T.W. "Engineering Symmetry-breaking Nanocrescent Arrays for Nanolasing," ***Adv. Funct. Mater.*** 1904157 (2019) DOI: 10.1002/adfm.201904157

14. Hu, J.; **Wang, D.**; Bhowmik, D.; Liu, T.; Deng, S.; Knudson, M.P.; Ao, X.; Odom, T.W. "Lattice-Resonance Metalenses for Fully Reconfigurable Imaging," ***ACS Nano*** 13, 4613-4620 (2019) DOI: 10.1021/acsnano.9b00651

15. Ao, X.; **Wang, D.**; Odom, T.W. "Enhanced Fields in Mirror-backed Low-Index Dielectric Structures," ***ACS Photonics*** 6, 2612-2617 (2019) DOI: 10.1021/acsphotonics.9b00931

16. Li, R.; **Wang, D.**; Guan, J.; Wang, W.; Ao, X.; Schatz, G.C.; Schaller, R.C.; Odom, T.W. "Plasmon nanolasing with aluminum nanoparticle arrays," ***J. Opt. Soc. Am. B*** 36, 104-111 (2019) DOI: 10.1364/josab.36.00e104

17. Liu, J.; Wang, W.; **Wang, D.**; Hu, J.; Ding, W.; Schaller, R.D.; Schatz, G.C.; Odom, T.W. "Spatially Defined Molecular Emitters Coupled to Plasmonic Nanoparticles," ***Proc. Natl. Acad. Sci.*** 116, 5925-5930 (2019) DOI.org/10.1073/pnas.1818902116

18. Hooper, D. C.; Kuppe, C.; **Wang, D.**; Wang, W.; Guan, J.; Odom, T.W.; Valev, V.K. "Second harmonic spectroscopy of surface lattice resonances," ***Nano Letters*** 19, 165-172 (2019) DOI: 10.1021/acs.nanolett.8b03574

19. Knudson, M.P.; Li, R.; **Wang, D.**; Wang, W.; Schaller, R.D.; Odom, T.W. "Polarization-Dependent Lasing Behavior from Low-Symmetry Nanocavity Arrays," ***ACS Nano*** 13, 7435-7441 (2019) DOI: 10.1021/acsnano.9b01142

20. Cherqui, C.; Bourgeois, M.R.; **Wang, D.**; Schatz, G.C. "Plasmonic Surface Lattice Resonances: Theory and Computation," ***Accounts of Chemical Research*** 52, 2548-2558 (2019) DOI: 10.1021/acs.accounts.9b00312

21. Li, R.; Bourgeois, M.R.; Cherqui, C.; Guan, J.; **Wang, D.**; Hu, J.; Schaller, R.D.; Schatz, G.C.; Odom, T.W. "Hierarchical Hybridization in Plasmonic Honeycomb Lattices," ***Nano Letters*** 19, 6435-6441 (2019) DOI: 10.1021/acs.nanolett.9b02661

22. **Wang, D.**; Wang, W.; Odom, T.W. *et al.* "Roadmap on Plasmonics: Nanoarray Lasing Spasers," ***Journal of Optics*** 20, 043001 (2018) DOI: 10.1088/2040-8986/aaa114

23. Trivedi, D.; **Wang, D.**; Odom, T.W.; Schatz, G.C. "Model for Describing Plasmonic Nanolasers Using Maxwell-Liouville Equations with Finite-difference Time-domain Calculations," ***Phys.***

Rev. A. 96**,** 053825 (2017) DOI: 10.1103/PhysRevA.96.053825

24. Yang, A.; **Wang, D.**; Wang, W.; Odom, T. W. "Coherent Light Sources at the Nanoscale," ***Annu. Rev. Phys. Chem.*** 68, 83-99 (2017) DOI: 10.1146/annurev-physchem-052516-050730

25. Wang, S.; **Wang, D.**; Hu, X.; Li, T.; Zhu, S. "Compact Surface Plasmon Amplifier in Nonlinear Hybrid Waveguide," ***Chinese Physics B*** 25, 7 (2016)

RESEARCH EXPERIENCE

University of California, Berkeley, Berkeley, CA

- Postdoctoral research hosted by Junqiao Wu

  Highlight activities include:

  - Achieved long-range optical interactions between epsilon-near-zero thin film materials and their analogy to superconducting proximity effect in electronic systems
  - Demonstrated that near-zero-index materials can serve as a cladding layer for low-loss and geometry-invariant optical waveguides for miniaturized photonics
  - Realized cavity-free lasing robust to lateral cavity geometry deformation based on zero-index materials with numerical methods

  These works are funded by the Miller research fellowship.

Northwestern University, Evanston, IL

- Graduate research co-advised by Teri W. Odom and George C. Schatz

  Highlight activities include:

  - Achieved controlled multi-modal lasing from metal nanoparticle superlattices that enable access to multiple band-edge states in the photonic band structure
  - Realized a mechanically tunable nanolaser based on metal nanoparticles on a flexible polymer matrix, as inspired by color changes of chameleons in nature
  - Collaboratively demonstrated deterministic coupling of quantum emitters in hBN to plasmonic nanocavities for enhanced single-photon emission
  - Collaboratively achieved continuous-wave nanoscale lasing at visible frequencies under near-infrared pumping with *record-low* power thresholds
  - Established a robust computational approach in finite-difference time-domain methods to investigate time- and spatial- dependent lasing buildup in small photonic cavities

  These works resulted in 8 first-author publications in Nature Nanotechnology, *Nature Materials*, *Nano Letters*, *ACS Photonics etc.*

RESEARCH INTEREST

My future group will focus on materials development, structural design, and large-scale nanofabrication for emerging optical behavior at the nanoscale, with target applications in integrated photonics, energy harvesting, and quantum engineering. Detailed plans include:

1. Integrated Nanophotonics for Next-generation Circuits

My vision for next-generation integrated photonics, which are miniaturized, multiplexed, and low-loss, will focus on two key components—light generation and propagation. Going beyond miniaturized lasers based on optical pump, we will use semiconductors as the gain media for nanoscale lasers compatible with electrical pump. We also plan to realize low-loss photonic waveguides using semiconducting oxides as the cladding layer for submicron device footprint with reduced optical scattering and crosstalk in between.

2. Tunable Thermal Photonics for Energy Harvesting

We will investigate structured nanoscale materials to tackle key challenges in thermal photonics, with a focus on the spatial and spectral engineering of blackbody radiation. We plan to achieve directional thermal emission by coherent phase modulation with metasurfaces and zero-index materials for wavefront shaping in the near field. We will also aim for reconfigurable, spatial control of heat flow by external stimuli.

3. Manipulating Quantum Interactions with Large-scale Nanophotonics

For the long term, we aim to build a versatile platform based on large-scale nanophotonics to interface with different materials for manipulating quantum interactions. The key question to address is what emerging light-matter interactions would arise as the quantum emitters are placed at the optical near fields with both spatial and spectral precision. We aim to acquire enhanced coherence beyond the thermal dephasing noise at room temperature and mediate long-range quantum interactions on a large scale.

CONFERENCES & PRESENTATIONS

1. **MRS Fall Meeting** Boston, MA 2022
   Talk: “Low-loss, geometry-invariant optical waveguides with zero-index materials”
2. **San Francisco State University Physics Colloquium** San Francisco, CA 2022
   Invited talk: “Emerging Optics from Structured Nanomaterials”
3. **UC Berkeley Quantum Materials Seminar** Berkeley, CA 2019
   Invited talk: “Extraordinary Optics from Structured Nanoparticles”
4. **UC Berkeley Nano Seminar Series** Berkeley, CA 2019
   Invited talk: “Extraordinary Optics from Structured Nanoparticles”
5. **ACS Fall Meeting** San Diego, CA 2019
   Invited talk: “Extraordinary Optics from Structured Nanoparticles”
6. **Vannevar Bush Faculty Fellows Annual Meeting** Washington, D.C. 2019
   Poster: “Functional and Hierarchical Nanoscale Metamaterials”
7. **MRS Fall Meeting** Boston, MA 2018
   Talk: “Stretchable Nanolasing from Hybrid Quadrupole Plasmons”
8. **Gordon Conference** Waterville Valley, NH 2018

Poster: “Structural Engineering in Plasmon Nanolasers”

9. **Nanjing University Tiandi Symposium** Nanjing, China 2017
   Invited talk: “Structural Engineering in Plasmon Nanolasers”
10. **MRS Fall Meeting** Boston, MA 2017
    Talk: “Band-edge Engineering for Controlled Multi-modal Nanolasing in Plasmonic Superlattices”
11. **Northwestern SPIE-MRSEC Student Seminar Series** Evanston, IL 2017
    Invited talk: “Structural Engineering in Plasmon Nanolasers”
12. **OSA Incubator on Science & Applications of Nanolasers** Washington, DC 2016
    Invited talk: “Lasing from Plasmonic Nanocavity Arrays”
13. **Gordon Conference** Newry, ME 2016
    Poster: “Band-edge Engineering in Hierarchical Plasmonic Nanolasers”
14. **APS March Meeting** San Antonio, TX 2015
    Poster: “Superlattice Plasmons in Finite Nanoparticle Arrays”

PRESS RELEASES

1. "Structuring Nanomaterials for Optics", *Miller Fellow Focus*, *Miller Institute Newsletter* (Winter 2021)
2. "Forbes 30 Under 30 2021 List", *Forbes* (December 2020)
3. "Upconverting Nanolasers from Subwavelength Plasmons: Stability and Ultralow Powers", *energy.gov* (March 2020)
4. "Tiny laser packs a punch", *Berkeley Lab’s Molecular Foundry News* (Nov. 2019)
5. "Tiny, biocompatible laser could function inside living tissues", *National Science Foundation Research News* (Oct. 2019)
6. "Biocompatible nanolaser small enough to treat brain diseases", *springwise.com* (Oct. 2019)
7. "Lasing under ultralow pumping", *Nature Materials News and Views* (Oct. 2019)
8. "Tiny, Biocompatible Laser Could Function Inside Living Tissues", *Columbia Engineering News* (Oct. 2020)
9. "Tiny, biocompatible laser could function inside living tissues", *phys.org* (Sep. 2020)
10. "Tiny, biocompatible nanolaser could function inside living tissues", *Northwestern Now* (Sep. 2019)
11. "Nanolaser functions inside living human tissue", *Laboratory News* (Sep. 2019)
12. "Tiny, biocompatible laser could function inside living tissues", *Nanotechnology Now* (Sep. 2019)

13. "The chameleon and the crystal maze", *Laboratory News, UK* (Sep. 2018) [Highlighted as the featured article and the cover story]
14. "Mimicking the Master of Camouflage", *Chicago Biomedical Consortium Success Story* (July 2018)
15. "Nanolaser Changes Color when Stretched", *Chemical & Engineering News* (July 2018)
16. "Chameleon-inspired Nanolaser Changes Colors", *National Science Foundation's webhomepage* (June 2018)
17. "Chameleons Inspire Mechanochromic Nanolaser", *Physics World* (June 2018)
18. "Chameleon-inspired Nanolaser Changes Colors", *ScienceDaily* (June 2018)
19. "Chameleon-inspired Nanolaser Changes Colors", *Northwestern Now* (June 2018)
20. "Northwestern's New Chameleon-Inspired Laser Changes Colors", *WTTW* (June 2018)
21. "Nanolasing: Multimode Superlattice Arrays", *Nature Nanotechnology News and Views* (Sep. 2017)
22. "New Laser Design Offers More Inexpensive Multi-color Output", *Northwestern Now* (July 2017)
23. "Controlling Multi-modal Nanolasing with Plasmonic Superlattices", *Nanowerk News* (July 2017)

PROFICIENCES AND SKILLS

Nanofabrication

Bench-top Multi-scale Pattern Transferring, Phase-shift Photolithography, E-beam Lithography, Pulsed Vapor Deposition, E-beam Evaporation, Reactive Ion Etching, Scanning Electron Microscopy

Optical characterization

Optical Set-up, Lasing Detection, Time-resolved Photoluminescence, Angle-resolved Optical Spectroscopy, Dark-field Microscopy, Raman spectrometer

Modeling and Computation

Finite-Difference Time-Domain (FDTD) Modeling, COMSOL Multiphysics, MATLAB, Mathematics, Adobe Illustrator, Blender 3D Software

LEADERSHIP EXPERIENCE

2020- Glovebox, Raman Spectrometer Instrument Manager, the Wu Group

2019- Microscope Instrument Manager, the Wu Group

2016-18 Laser Instrument Manager, the Odom Group

2015-17 Rotational-stage Spectrometer Manager, the Odom Group

2016 Management for Scientists and Engineers Certificate, Northwestern University,

Kellogg School of Management

2014-15 Cleanroom Manager, the Odom Group

TEACHING EXPERIENCE

Guest Lecturer, University of California, Berkeley Fall 2019

Course: Optical Materials and Devices

Responsibilities: Invited to present one lecture on my research work to graduate students. Developed and delivered a 90-minute lecture with interactive sections.

Graduate Teaching Assistant, Northwestern University Spring 2018

Course: Introductory Physics of Materials

Responsibilities: Hosted the office hours, refined assignments questions, and graded for an undergraduate-level course with 22 students.

SERVICE & OUTREACH

Founding co-chair, Gordon Research Seminar June 2023

Subsection: Lasers in Micro, Nano and Bio Systems, West Dover, VT

Miller Institute Ambassador 2022

University of California, Berkeley

Invited panelist, WISE National Conference, Canada Jan. 2022

University of Toronto

"Meet with a Miller Fellow" outreach program at El Cerrito High School 2020-21

University of California, Berkeley

Morning mentor, Tutoring program at Nichols Middle School Winter 2018

Northwestern University

Professional Development Co-chair, McCormick Graduate Leadership Council 2014-16

Northwestern University

Ad Hoc Reviewer

ACS Photonics, *Optica, Optics Letters, Applied Optics*, *Optics and Laser Technology*, *Materials*

REFERENCE CONTACTS

Professor Teri W. Odom

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Chair, Department of Chemistry; Editor-in-Chief, *Nano Letters*
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Professor Junqiao Wu

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